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MECHANICAL ENGINEERING AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

BY

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VICE-PRES. AM.SOC.M.E.

To be presented at the Panama-Pacific Exposition Meeting of the American Society of Mechanical Engineers, San Francisco, September 16 and 17, 1915.

MECHANICAL ENGINEERING AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

By G. W. Dickie

ABSTRACT OF PAPER

The Exposition at San Francisco shows very clearly the changes which have taken place in mechanical engineering since the great exposition in Chicago in 1892.

The striking feature of the engineering exhibits is that the steam engine is not represented. The gas and oil internal combustion engine exhibit is very complete, however, and illustrative of the present state of the art.

Hydroelectric machinery, especially as developed on the Pacific Coast, is well represented by an impressive exhibit.

Testing machines of all kinds are shown, also automatic and other machine tools, although the number of exhibits of the latter is not great.

Machinery for making wooden boxes and tin cans, as developed for use in the fruit growing state of California, is represented.

Oxy-acetylene cutting and welding apparatus, saws, abrasives and other cutting machines form impressive exhibits.

Complete refrigeration plants for ice-making, food preservation and other purposes are included.

Pumps, hydraulic and electric apparatus for handling materials, meters and numerous auxiliaries serve to complete what is a very representative assembly of machinery and mechanical appliances.

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MECHANICAL ENGINEERING AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION

By G. W. Dickie, San Francisco
Vice-President of the Society

Before taking up the subject of this paper, I would like to say something regarding the Exposition itself. It would be impossible to portray, either by word or illustration, an adequate conception of the wonderful external beauty of this, especially when seen by any of the varied effects of light and shade so common to the gateway between the ocean and the great Bay of San Francisco. It may always remain a doubtful point whether this "city" of many colors which stood for one year by the Golden Gate appeared more beautiful when emerging from the mist of early morning in all its dazzling wealth of color; when standing in all its richness of detail under the cloudless mid-day sky; or when fading away in the twilight to burst into new and brighter splendor under a deluge of electric beams of light with new and wonderful effects from tinted towers and domes. From the hills which form the background of this wonderful creation, the scene is that of an ever-shifting panorama, the view from each point being a picture in itself.

2 Those who have been fortunate enough to see only for a day or two this wonderful exposition of the sculptor's art, the architect's science and the builder's skill, will never forget the charm of its setting; while those of us who have seen it through all the changing seasons of a California year, taking on new glories with the changing blossoms of the flowers out of which it springs, will find our thoughts taking new and better forms from this experience on through all the thinking days of our lives.

3 In some respects the Panama-Pacific International Exposition

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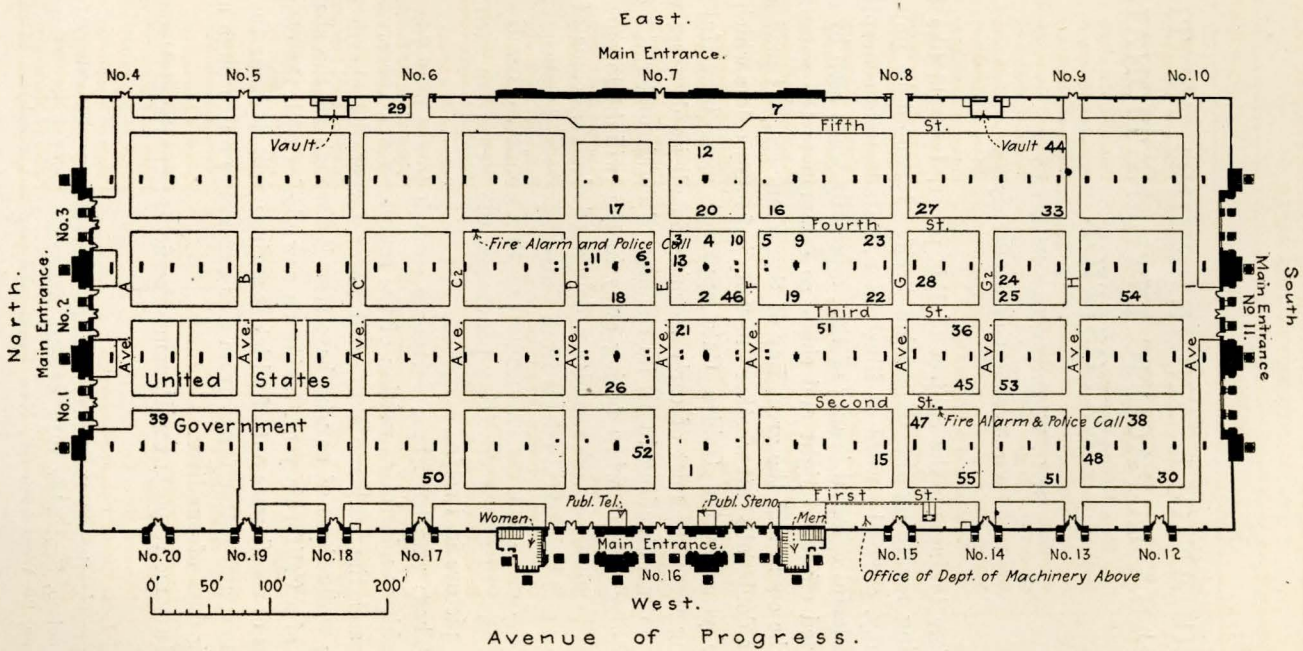

FIG. 1 FLOOR PLAN OF PALACE OF MACHINERY. NUMBERS ON PLAN INDICATE LOCATION OF EXHIBITS, SEE TABLE 1.

TABLE 1 EXHIBITS AT THE PANAMA-PACIFIC INTERNATIONAL EXPOSITION MENTIONED IN THIS PAPER

No.	Exhibitor	Location of Exhibit
1	Standard Gas Engine Company	Palace of Machinery
2	Union Gas Engine Company	Palace of Machinery
3	Gas Engine and Power Company	Palace of Machinery
4	C. L. Seabury Company	Palace of Machinery
5	Van Blerk Motor Company	Palace of Machinery
6	Imperial Gas Engine Company	Palace of Machinery
7	Buffalo Gasoline Motor Company	Palace of Machinery
8	Wisconsin Machinery and Mfg. Co	Palace of Transportation
9	Loew-Victor Engine Co	Palace of Machinery
10	Waterman Marine Motor Co	Palace of Machinery
11	August Mietz	Palace of Machinery
12	New London Ship & Engine Co	Palace of Machinery
13	Fulton Mfg. Co	Palace of Machinery
14	International Harvester Co	Palace of Agriculture
15	Western Gas Engine Corporation	Palace of Machinery
16	Doak Gas Engine Co	Palace of Machinery
17	Bessemer Gas Engine Co	Palace of Machinery
18	Busch-Sulzer Bros. Diesel Engine Co	Palace of Machinery
19	McIntosh & Seymour Corporation	Palace of Machinery
20	Pelton Water Wheel Co	Palace of Machinery
21	Tinius Olsen Testing Machine Co	Palace of Machinery
22	Warner & Swasey Co	Palace of Machinery
23	Morton Mfg. Co	Palace of Machinery
24	Fred. Ward & Sons	Palace of Machinery
25	Gould & Eberhardt	Palace of Machinery
26	Crane Co	Palace of Machinery
27	Landis Tool Co	Palace of Machinery
28	Wm. S. Doig Co	Palace of Machinery
29	Geo. D. Parker	Palace of Machinery
30	Max Ams Machine Co	Palace of Machinery
31	E. W. Bliss Co	Palace of Machinery
32	U. S. Army Ordnance Department	Palace of Machinery
33	Carborundum Co	Palace of Machinery
34	Davis-Bournonville Co	Palace of Manufactures
35	Henry Disston & Sons, Inc	Palace of Manufactures
36	Dreis & Krump Mfg. Co	Palace of Machinery
37	Geometric Tool Co	Palace of Varied Industries
38	Hydraulic Press Mfg. Co	Palace of Varied Industries
39	Henry G. Thompson & Sons	Palace of Varied Industries
40	Larsen Ice Machine Co	Palace of Food Products
41	York Mfg. Co	Palace of Food Products
42	Vulcan Iron Works	Palace of Agriculture
43	Automatic Refrigerating Co	Palace of Horticulture
44	Dodge Mfg. Co	Palace of Machinery
45	Union Oil Co. of Cal	Palace of Machinery
46	Standard Oil Co	Palace of Machinery
47	A. P. Smith Mfg. Co	Palace of Machinery
48	Shepherd Electric Crane & Hoist Co	Palace of Machinery
49	General Electric Co	Palace of Manufactures
50	Neptune Meter Co	Palace of Machinery
51	National Meter Co	Palace of Machinery
52	Luitwieler Pumping Engine Co	Palace of Machinery
53	Layne & Bowler Corporation	Palace of Machinery
54	Krogh Mfg. Co	Palace of Machinery
55	American Well Works	Palace of Machinery

is not equal to some of the great international exhibitions of the past, yet it shows very clearly the changes which have taken place during the past 22 years, or since the Columbian Exposition, particularly in mechanical engineering. At the lake front of the Chicago Exposition, there was a full-sized model of the first three battleships then building for the U. S. Navy. This model was built of bricks and concrete on piles and in it the Navy Department had a very instructive exhibit. Today the actual battleship, thus portrayed on Lake Michigan, lies in front of our Exposition as an illustration of a type now passing away, but with a twenty years' history to think of, of which the model on the lake shore gave no intimation.

4 The first thing that the mechanical engineer observes on entering the Palace of Machinery at the Panama-Pacific International Exposition is the entire absence of the steam engine. There is not a steam engine of any kind in operation, nor a steam boiler under steam. This is the first international exposition where the steam engine, as a prime mover, has been so conspicuous by its absence. On first thought the engineer might take this as evidence that the steam engine, after a century or more of development and a service to industry beyond reckoning, had suddenly reached a stage of innocuous desuetude and had ceased to rank as the greatest machine that the mechanical arts had produced. On second thought, however, he would have to admit that, of all the power developed by the combustion of fuel, more than 90 per cent is developed in the cylinders of steam engines or the rotors of steam turbines. His third thought would probably bring him to the conclusion that the steam engine, in all its varied forms, has reached that stage of development when no striking improvements can be looked for; in fact, the steam engine has in a sense reached its prime, and may be expected to continue doing a large proportion of the work rendered possible by the combustion of fuel, either liquid or solid. While the steam engine was advancing to the place it now occupies and many improvements were being made, the builder with something new, something that he considered an advance, was ready to show his best work at an exposition. This great prime mover has now reached maturity, and will only take second place when the internal combustion engine has reached such a robust maturity as to enable it to do on a much smaller diet what our great steam engines are doing.

5 The fact that California is a great fuel oil producing state may be one reason why the steam engine forms no part of the machinery

exhibits; yet the great bulk of California oil used for fuel is consumed under steam boilers. There is an impression among engineers, and especially among the younger members of the profession, that the steam engine is nearing the close of a great career, and on that account is too old a thing to attract much attention at an exposition.

6 The separate generator and the separate condenser, the crowning achievements in the early days of steam engines, are, in these days of quick returns, considered antiquated; and, acting on the principle that there is no time to be lost in dealing with heat, we are now advised to burn our fuel as rapidly as possible in the engine

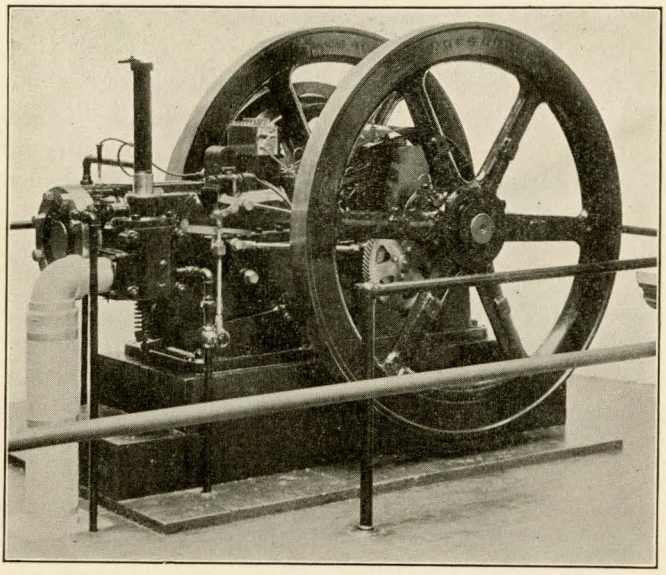

FIG. 2 STATIONARY GAS ENGINE EXHIBITED BY WESTERN GAS ENGINE CORPORATION, CYLINDER 12½ IN. BY 20 IN. 235 R.P.M. 60 H.P.

cylinder, to get the power out of it instantly and let it go—hence the internal combustion engine.

7 There is quite a large display of gas engines in the Palace of Machinery, the Transportation Palace, and the Palace of Agriculture. These engines may be classed as:

8 (*a*) *Marine engines, Otto type, constant volume class,* for distillate fuels such as gasoline and kerosene. In this class there are some fine exhibits, such as the Standard Gas Engine Company's exhibit, showing a good line of well designed and carefully finished

engines from 100 h.p. down to small sizes. The Union gas engine, shown cut open to illustrate the movements of piston and valve gear, is a fine type of marine gas engine. The Gas Engine and Power Co. and C. L. Seabury Company show interesting examples of engines.

9 The Van Blerck Motor Co. exhibit some handsome engines of attractive design, which present new features. The Imperial Gas Engine Co. have an attractive exhibit of substantial-looking engines; while others in the same class, such as the Buffalo Gasoline Motor Co., the Wisconsin Machinery and Manufacturing Co., the Loew-Victor Engine Co. and the Waterman Marine Co. are all well worthy of study. This type of marine gas engine is well represented at the Exposition.

10 (*b*) *Marine engines, Otto type, constant volume class,* with injection for heavy oils. Of this type there is but one example, that of August Mietz. It is a well designed and strongly built engine.

11 (*c*) *Marine Diesel oil engines.* In this class there are two exhibits—that of the New London Ship and Engine Co. and that of the Fulton Manufacturing Co. The first-named works under a load of about 80 per cent of full power, the normal power being 200 horse-power. These engines illustrate the present state of the art in Diesel engines of moderate power.

12 (*d*) *Stationary engines, Otto type, constant volume class,* for distillate fuels such as gasoline and kerosene. Of this class a great variety is shown, suitable for a wide range of work. Mention might be made of the exhibit of the International Harvester Co., which shows these engines designed for all purposes to which motors can be applied on the farm and all other rural work. There is a rich field in this exhibit, which gives information as to the best way to hitch up a gas engine to almost any kind of work.

13 The Western Gas Engine Corporation exhibits stationary gas engines which present some features worthy of study. These engines have an unusually long stroke for gas engines, and were the first to introduce water into the carburetor. The valve gear is very simple, with free-moving parts operated by a rod from a single eccentric.

14 The Doak Gas Engine Co. and the Bessemer Gas Engine Co. show some good work under this class. The Standard Gas Engine Co.'s exhibit is also well worthy of attention.

15 (*e*) *Stationary engines, Otto type, constant volume class,* with injection for heavy oils. Under this type some very good exhibits

are shown, notably those by August Mietz and the Bessemer Gas Engine Co.

16 (*f*) *Stationary engines, Otto type, constant volume class,* for gaseous fuels. In this class there are two exhibitors, the Standard Gas Engine Co. and the Western Gas Engine Corporation. As the arrangements of valve gear, etc., of these engines are quite different in design and function, they offer a good opportunity for comparison.

17 (*g*) *Stationary Diesel oil engines.* In this class there are

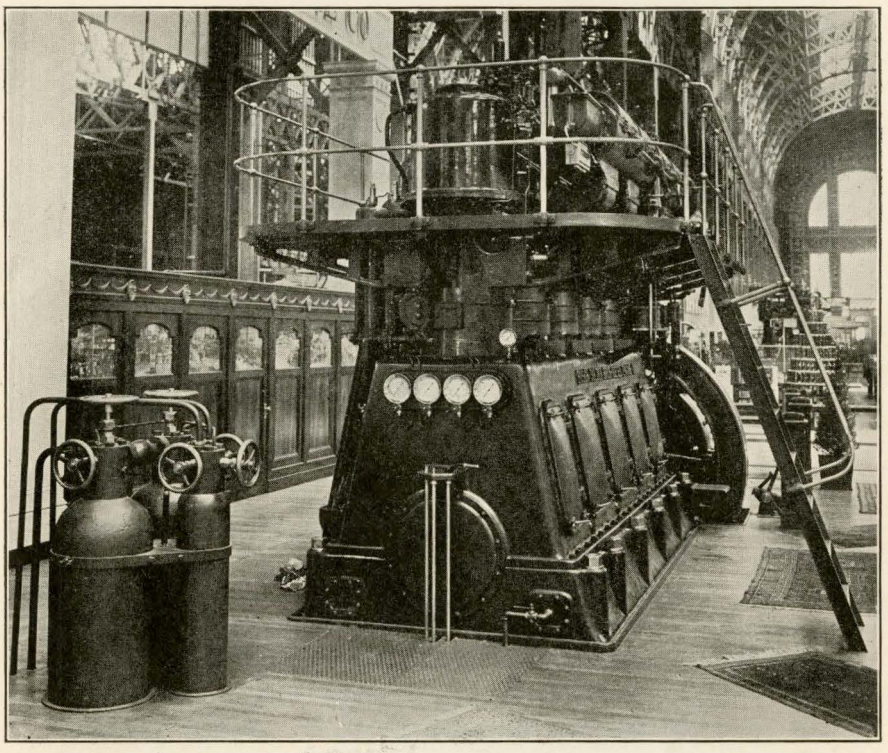

FIG. 3 500-H.P. DIESEL ENGINE EXHIBITED BY BUSCH-SULZER BROS. DIESEL ENGINE CO.

two exhibitors, the Busch-Sulzer Bros. Diesel Engine Co. and the McIntosh and Seymour Corporation. Both show fine examples of vertical engines of 500 h.p. each and both illustrate the best that these makers produce. Each engine is operating with Star distillate, which is probably the nearest to California crude oil with which it is safe to work these engines. (It is expected that an exhaustive

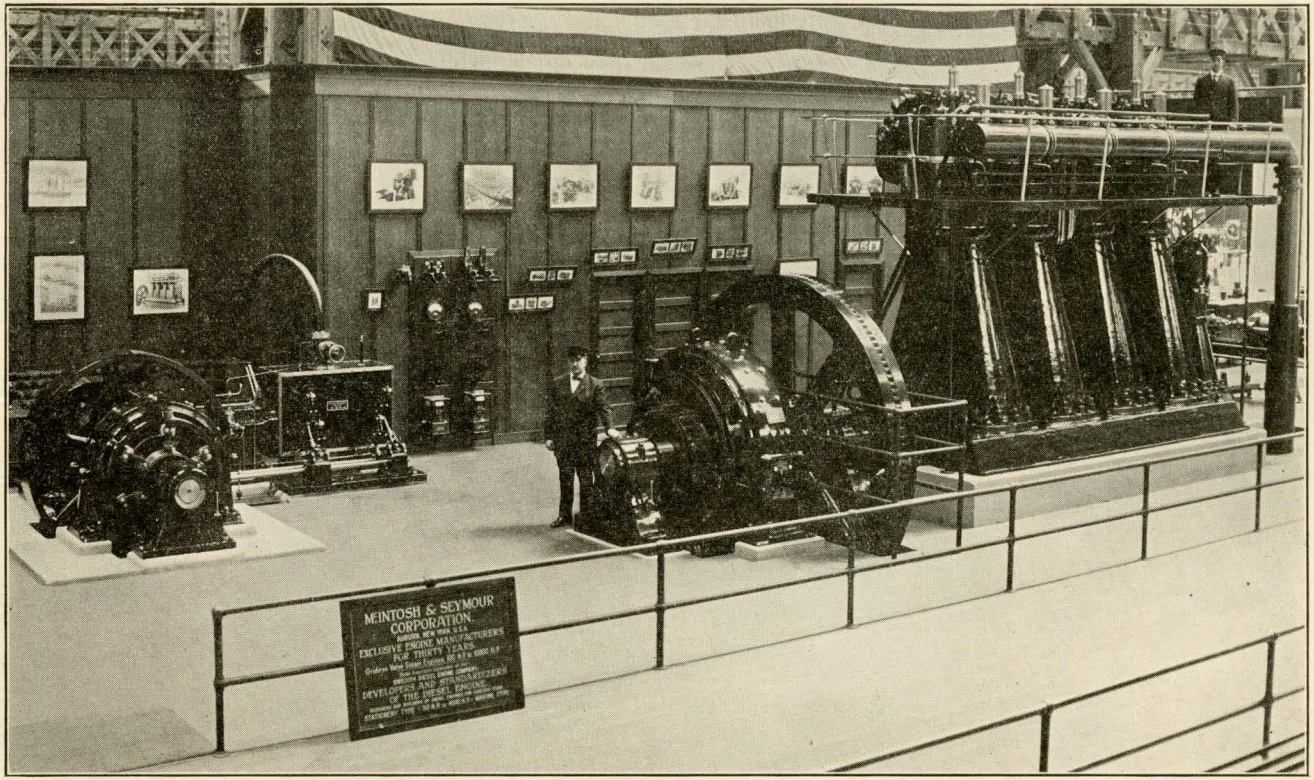

FIG. 4 500-H.P. DIESEL ENGINE EXHIBITED BY McINTOSH AND SEYMOUR CORPORATION

test will be made of these two engines to determine which should receive the highest award.)

18 On the whole, the exhibit of gas and oil internal combustion engines is complete and illustrative of the present condition of the art, and the mechanical engineer interested in this form of prime mover finds a rich field for study at this Exposition.

19 In the special types of gas engines or motors shown in the Transportation building, a large and varied display illustrating their application to automobiles, motor trucks and motor cycles, gives ample opportunity for study in this interesting field. The beautiful workmanship on many of these show the taste and skill that has been brought to bear upon the development of this immense industry.

20 California is not only rich in liquid fuel, making it an ideal home for the internal combustion engine, but the whole Pacific Coast is a land of liquid power, ready to be used without the necessity of burning anything to produce it. The winter snows on the high Sierras and other mountain ranges forming the eastern boundary of the Pacific slope is the source of this vast accumulation of stored-up energy, which, in the past thirty years or so, has been more and more converted into electrical energy and carried for hundreds of miles to the points where it is needed, to operate factories and street cars, light cities, warm houses and cook food.

21 It would be surprising, indeed, should there be nothing in this Exposition which is more of an electrical display than any of its predecessors, and that would give the engineer an adequate conception of how the snows of the mountains were utilized in furnishing light, heat and power to the people who live in the valleys and on the plains below. It is not surprising, therefore, that the most impressive exhibit in the Machinery Palace should be that of the Pelton Water Wheel Co. The writer felt his inability to do justice to this splendid example and asked help from W. A. Doble, chief engineer of the Pelton Water Wheel Co. and the designer of much of the display made, who kindly furnished a description from which the following is taken:

22 Hydraulic machinery has played such an important role in the development of the West, that one's expectations are raised quite high. The exhibit of the Pelton Water Wheel Co., covering every phase of rotative hydraulics and hydraulic control, can be divided into two parts: *Operating division,* and *display division.*

23 It being impossible to secure water, either in sufficient quantity or under pressure desirable for driving hydraulic prime movers,

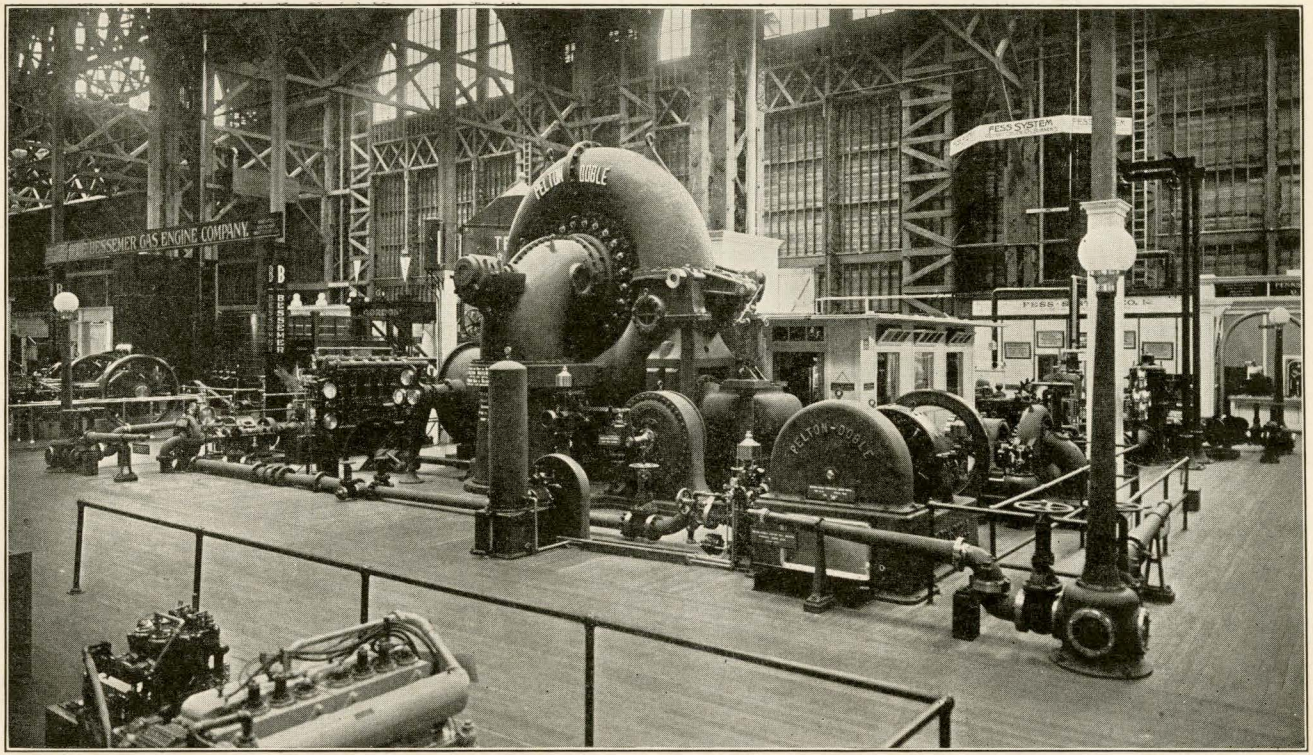

FIG. 5 PELTON WATER WHEEL CO.'S EXHIBIT, SHOWING 20,000-H.P. PELTON-DOBLE TURBINE

an effective combination of turbine pumps, drawing water from a common sump, and discharging, through control devices and pipe lines of the types customarily employed in hydroelectric practice, into water wheels of both the tangential and turbine types using the sump as a tail race, has been worked out.

24 The operating division consists of two sections:

a A high head pumping project combined with a high head hydroelectric development where water economy is important, and employing tangential water wheels.

b A deep well pumping project combined with a medium head hydroelectric development, employing mixed flow turbines.

25 The high head pumping plant consists of a Pelton-Doble turbine pump, driven through a flexible coupling and herringbone speed-increasing gears by an internal combustion engine. The high speed shaft of these gears turns at 1800 r.p.m., the efficiency of transmission at full rated load of 150 h.p. being in excess of 98 per cent.

26 The engine is a 6-cylinder vertical type, developing 180 h.p. at 350 r.p.m. It uses heavy oil up to 18 deg. Beaumé for fuel and operates on the 4-stroke cycle with maximum compression not exceeding 450 lb. per sq. in. No ignition difficulties are experienced with this low compression.

27 The pump is a single stage uni-diffusion type, having a capacity of 1100 gal. per min. against a head of 300 ft. The impeller, of the closed non-overload type, hydraulic-balanced and made of bronze, is overhung. The discharge line, after passing through an 8 and 6-in. venturi ring, connects to a Pelton-Doble tangential unit, rated at 100 h.p. under 300 ft. head and operating at 300 r.p.m. This unit is of the single overhung, two-bearing type, with the armature of a 75-kw., 250-volt engine-type direct current generator carried between the bearings, and a flywheel overhung on the shaft end opposite the tangential runner.

28 The entire unit is mounted on a high pedestal sub-base, fitted at the water wheel end with a large window, which permits examination of the jet and bucket action.

29 The water wheel disc is steel, with ellipsoidal bronze buckets, saddle-mounted. Water from the high-pressure pump is applied through a needle nozzle, governing being accomplished by an oil pressure type governor mounted on the nozzle casting, and actuating the needle directly through suitable link and rockshaft connections. An auxiliary relief needle nozzle avoids excessive pressure rise in the

pipe line and minimizes water waste during governing cycle. The needle of this nozzle is connected to a spring-controlled oil cylinder,

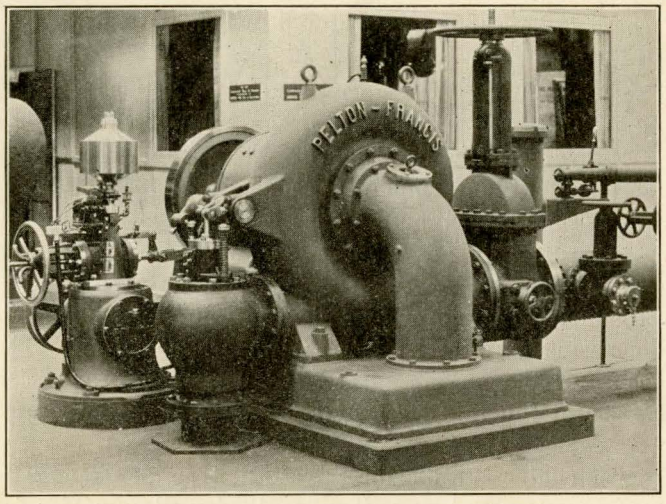

FIG. 6 50-H.P. PELTON-FRANCIS WATER WHEEL. 1400 R.P.M. PELTON WATER WHEEL CO.'S EXHIBIT

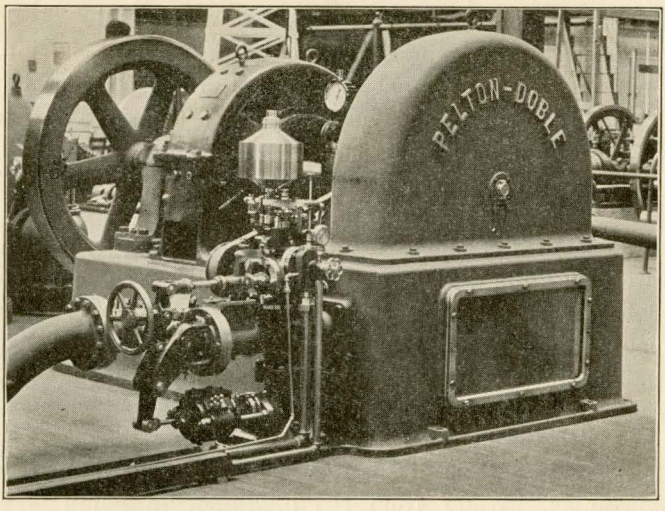

FIG. 7 100-H.P. PELTON-DOBLE WATER WHEEL. 300 FT. HEAD. PELTON WATER WHEEL CO.'S EXHIBIT

known as the cascade cylinder. Ports, adjustable from the outside of the cylinder, determine the time element of piston travel. The same

link and rockshaft system that actuates the main needle nozzle is connected to the piston of the cascade cylinder, the relative motion (and thus the nozzle area) being equal and opposite in direction when the time element of the cascade cylinder is zero. With this setting, the auxiliary nozzle merely acts as a synchronous bypass, and the water quantity is constant. Where water economy is of importance, the time element of the cascade cylinder is so adjusted that a rate of closing of the main needle which does not raise the surge pressure to a dangerous point will not open the auxiliary needle. Higher closing rate opens the auxiliary needle, which is then returned to closed position by the compression springs of the cylinder mounting at a rate that will not cause dangerous surge pressures. This is the

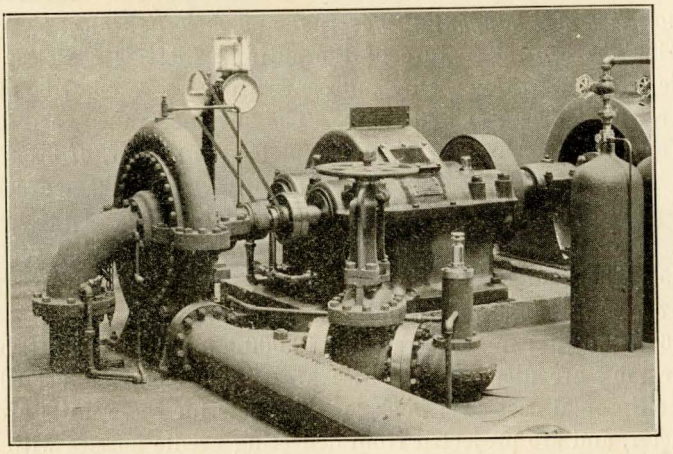

FIG. 8 CENTRIFUGAL PUMP AND HIGH SPEED TRANSMISSION. PELTON WATER WHEEL CO.'S EXHIBIT

position of maximum economy. A baffle plate, employing the vortex principle, is set in the casing and receives the impact of the relief stream, quenching its energy.

30 The deep well pumping plant consists of a Pelton-Doble bore-well type turbine pump, with a capacity of 4500 gal. per min. against a head of 60 ft. and driven at 1760 r.p.m. by a vertical motor mounted on the pump pedestal. The maximum diameter of the pump is 22½ in., permitting its easy entrance into a 24-in. bored well.

31 The discharge orifice has a diameter of 14 in., and has, bolted directly to it, a riveted steel pipe line which leads to a Pelton-Francis turbine. A venturi ring, 18 in. in diameter, is set in this

line. This unit operates under a head of 50 ft. and develops 50 h.p. at 1400 r.p.m., an unusually high specific speed. The runner is balanced and is of the Francis type. The wicket gates are controlled by a self-contained governor, which actuates a water economizing cascade relief valve as well. The principle of operation is the same as the governor employed with the tangential unit, except that an oil reservoir and belt driven pump are placed in the governor base.

32 The entire operating division is arranged for laboratory investigations, and more than 800 tests have been conducted by independent engineers and the staff of the Pelton Water Wheel Co. During the autumn semester of the local universities, 1915, additional tests will be conducted by senior students of the engineering departments.

33 The display division may be divided into four sections: *Francis turbines, tangential, governor* and *miscellaneous.*

34 The central feature of the entire exhibit is a Pelton-Doble single, overhung-runner, single-discharge turbine, rated at 20,000 h.p. under 500 ft. head, at 360 r.p.m. The entrance valve, casing, draft tube and governor are assembled complete; the runner, of bronze with steel hub and forged wearing rings, and fitted with leakage evacuators, is displayed on a separate pedestal. The main valve, of the butterfly type, is 66 in. internal diameter, with body of annealed cast steel.

35 The tangential section may be divided into two groups: *Hydroelectric prime movers* and *water motors.*

36 Two runners, each rated at 10,000 h.p. under 1350 ft. head at 360 r.p.m., are displayed. These are of the chain connected type, with ellipsoidal cast steel buckets. The jets for these units are 7 in. diameter, and are projected from deflecting needle nozzles with motor operated manual controlled needles and governor controlled deflection. One of these nozzles, assembled complete with motor, and three needles, pedestal mounted, are displayed. A single bucket of the chain connected type, taken from a wheel rated at 14,000 h.p. under 870 ft. head at 200 r.p.m., is also displayed. A number of water motors of standard and special design complete the tangential section.

37 In the governor section are displayed a group of self-contained oil pressure type governors, of 5000 ft-lb. drawbar effort, and, in conjunction with a standard mounted tangential unit, an enclosed type of oil pressure governor having a drawbar effort of 80 lb.

38 The miscellaneous section includes a display of hydraulic giants of the types employed in placer mining and hydraulic fill construction.

39 The exhibits of machine tools are not very numerous and, out-

side of two very notable exhibits, there is nothing in this line that requires the attention and study of the mechanical engineer who has a fair knowledge of the modern machine tool. Before examining the machine tools it would be well to inspect the exhibit of the Tinius Olsen Testing Machine Co. as the records produced by such machines form the foundation work for all modern machine tool design. The mechanical engineer finds in this exhibit, which is probably the best in its class that has ever been exhibited by one maker, much food for thought and many admirable ideas in design.

40 Testing machines and apparatus for engineering research and

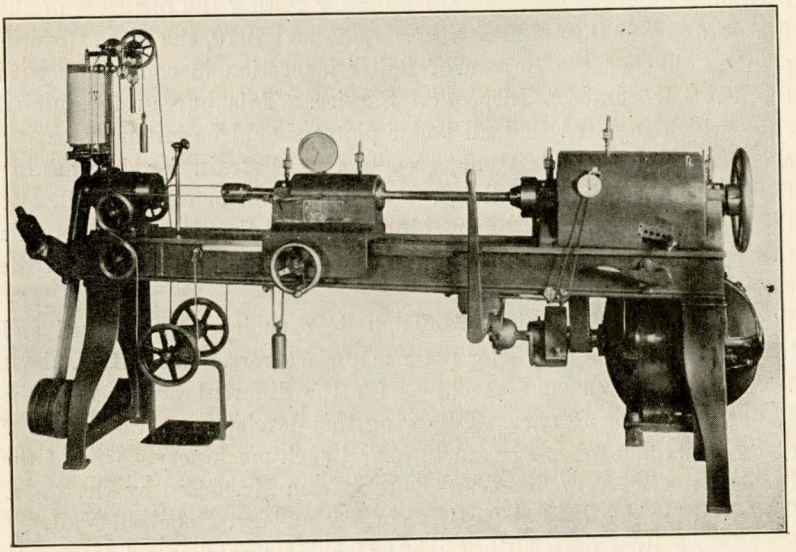

FIG. 9 UNIVERSAL EFFICIENCY TESTING MACHINE. TINIUS OLSEN TESTING MACHINE CO.'S EXHIBIT

development may be arranged in two main groups: *a* Apparatus and machines for testing structural materials in the form of specimens, as well as the testing of complete designs and structures. *b* Apparatus and machines for testing the materials from which tools are to be made, as well as testing the finished tools.

41 *a* Apparatus for testing materials in a crude way date from a very early period in the history of engineering. As soon as the engineer found it desirable and necessary to have some approximate data upon which to base the design, form, and strength of the thing he was to make, he had to do some testing even though he lacked the

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right machine with which to do it. Later, more improved apparatus was made and used by instructors and writers on technical subjects for formulating tables of factors for strains to be used by engineers in the design of different structures. These more or less crude testing machines were used in various places in Europe, and from these the engineering texts and handbooks were first developed.

42 In the United States, prior to 1870, very little progress was made in apparatus for ascertaining the actual strength of materials. One device may be mentioned as used by the U. S. Board of Ordnance for testing the cast iron used in gun making. We know also of one hydraulic press used by Captain Eads for testing the members of the first bridge over the Mississippi River. About 1870, the U. S. Government established the Bureau of Boiler inspection in connection with the U. S. Steamboat Inspection Service. This bureau formulated rules which required that all boiler plates should be tested by having a cupon from each plate subjected to tensile strain for determining the breaking strain, as well as the yielding point or elastic limit, also the reduction of area at the breaking point and the elongation between two points. Hence came the inquiry for and the development of the commercial testing machine.

43 The first machine of 40,000 lb. capacity was designed and built by Mr. Olsen for boiler plate manufacturers. Soon after, about 1870, he built ten such machines for the different branches of the Boiler Inspection Service. Following this development, the technical and engineering schools began to install such machinery. One of the first—if not the very first—was bought from Mr. Olsen by Dr. R. H. Thurston for the Stevens Institute of Technology, Hoboken, N. J.

44 As time passed the testing machine was changed in design and improved and put to more constant and varied use by all manufacturers of structural materials, as well as large users, and also in technical schools, where its use developed laboratories with apparatus of larger and more diversified forms and functions to include investigation of the more varied character and direction of stress to which materials are subjected in modern design.

45 In group *b* are classed what are termed efficiency testing machines. These machines are of more recent development, although a simple machine of this class was shown at the Centennial Exposition, 1876, in a file manufacturer's exhibit; it was probably made by him to demonstrate the most efficient method of file cutting, as well as the most reliable material for file making and the best method of tempering. Nothing more was publicly shown in this line until a few years

ago, when Edward Herbert of Manchester, England, placed on the market his file testing machine and a little later his machine for testing the efficiency of tool steels, especially modern high speed steels. A few of these machines are in use in this country. These two English machines are shown in Mr. Olsen's exhibit at the Exposition.

46 A few years ago, Mr. Olsen was called upon to design a machine for testing the efficiency of drills, taps, and dies. About two

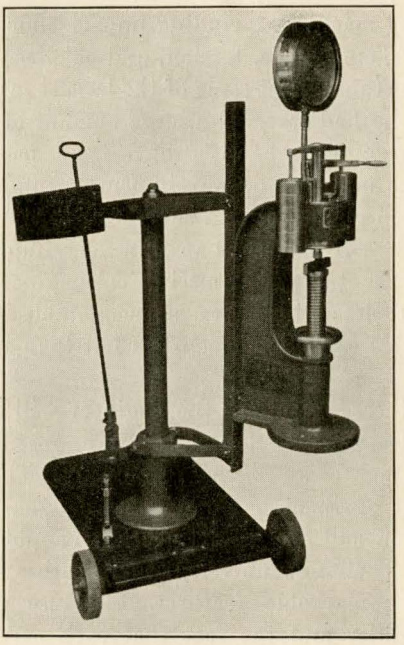

FIG. 10 BRINNELL TYPE HYDRAULIC HARDNESS TESTER. TINIUS OLSEN EXHIBIT

years ago this was worked into a practical machine for the Philadelphia Navy Yard and has proved satisfactory, filling all the requirements for this purpose. Later, by additional attachments, this machine has been perfected so as to make a universal tool as well as a tool steel testing machine. This machine in its newest form is shown in the Olsen exhibit; it will test tool steel, lathe and planer tools, milling cutters, drills, taps, dies, rimers, files, and hack saws, thus forming a practical efficiency testing machine for determining the quality of most tools as well as the most effective way to make and use them.

47 The Olsen exhibit is well worth a careful study by the mechanical engineer. Mr. Olsen himself is usually at the exhibit and he looks upon this fascinating collection of testing machines as his own children. As he knows all their little weaknesses as well as their good qualities, an hours' conversation with him is a liberal education in this subject. Here the observer will find the universal testing machine and instruments, spring testing apparatus, cement, concrete, and road material testing machinery; cloth, yarn, paper, rubber, and leather testing machines; oil testing machines, transverse testing machine, and special testing machines including impact, indentation, vibration, bending, hardness, endurance, torsion, and efficiency testing.

48 It is unfortunate that some of the largest machine tool makers of this country who had reserved a large amount of space in the Machinery Palace should have withdrawn from participation in the Exposition on the outbreak of war in Europe under the impression that the Exposition could not be a success under the conditions. This is to be regretted as it leaves a gap in a very important part of the machinery department that the mechanical engineer will not fail to observe. Nevertheless there are some notable exceptions whose presence makes this condition much less felt than it would otherwise have been.

49 Among these exceptions the engineer will not fail to notice the splendid collection of both automatic and semi-automatic tools exhibited by the Warner and Swasey Company. This company shows ten tools, several of them being of new design; the tools are all shown in operation and are attracting the favorable criticism of our best mechanics. Their new universal turret lathes are powerful tools and have some remarkable features. Because of their superior strength and rigidity and the fact that each carriage with its independent feeds is able to operate simultaneously, the lathes are enabled to produce a very large amount of work. They have equal facilities for both bar and chucking work. They have geared heads with splash lubrication. As many as eleven cutters may be used in the turrets and carriages of these lathes, all cutting at the same time and in one set up.

50 The other tools exhibited by this company belong to their line of screw machines and plain turret lathes which are so well known as the product of the Warner and Swasey Co. and are all characterized by the same scientific design and careful workmanship. The automatic boring and tapping machine used by all the large manufacturers of steam and water fittings for boring, facing and threading

their outlets, valves, and joints is also shown in operation. This machine finishes unions as fast as the operator can put them in the chuck and an average of 3500 one-inch unions are turned out in a day of nine hours by this machine.

51 The Warner and Swasey exhibit will be acknowledged by all mechanical engineers as the principal factor in redeeming the machine tool display at the Exposition from being classed as a very ordinary exhibit of machine tools, and its high character will command the admiration of the engineer.

52 Another exhibit that has given character to the display of

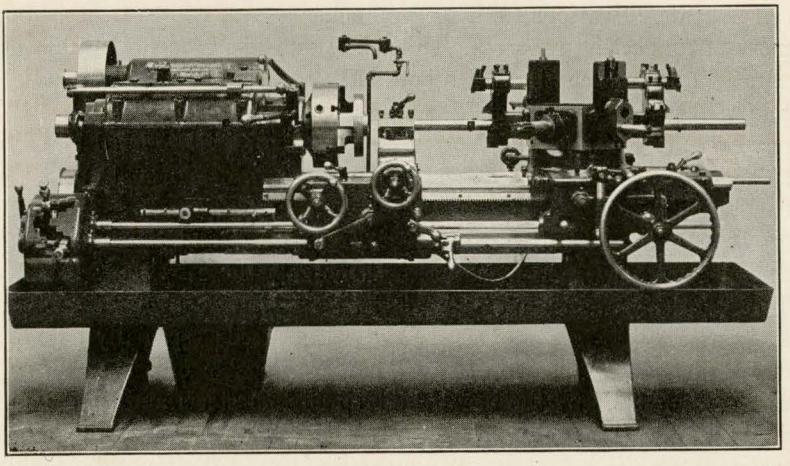

FIG. 11 UNIVERSAL HOLLOW HEXAGON TURRET LATHE EXHIBITED BY WARNER AND SWASEY CO.

machine tools at the Exposition is that of the Morton Manufacturing Co. This is an exhibit of draw-cut shapers, traveling head planers and key-seating machines. The draw-cut type has been developed by this company and lends itself to heavy cutting to a remarkable degree. The whole stress of cutting draws the work solidly and directly against the face of the main casting of the machine and eliminates the stresses from the table rail or the upper bolts holding the table as in the usual type of shaper. The tool arm or ram is under tensile stress in cutting, which tends to reduce or eliminate vibration; when the ram or arm is in compression, the heavier the cut the greater the danger of vibration. One feature of this type of shaper or planer is the facility it offers of shaping to lines, as the latter are on the outside in view of the operator and are not broken

or destroyed by the tool as it leaves the work. The tool beginning its work on the face next the operator, the lines on that face can be worked to very accurately as they are not broken or destroyed until cut out by the tool itself. This feature is of great value to the operator as well as the owner of the tool. There is an adjustable back bearing which forms a stop or abutment to the end of the vice when planing parallel with the jaws. With this stop it is only necessary to clamp the work sufficient to hold it as the thrust of the cut comes against the back bearer or stop. As the drawing or pulling cut overcomes vibration, it is possible to make forming tools to be used in these machines at a moderate cost. Rounding tools, either concave or convex, can be made of various radii for producing correct curves in finishing parts of connecting rods, etc. Cutters can also be used for machining parallel openings cutting down both sides at once. Being the originators of the draw-cut principle as applied to this class of machines, the makers have consistently followed up every indication offered by their extended use leading to further improvement in design and operating function.

53 In the collective exhibit of Fred. Ward and Sons there are shown some very good machine tools, notably those by the American Tool Works. The engine lathes shown are well constructed modern tools with easily adjusted feeds and with speeds especially adapted and designed for electric drive. They are capable of caring for the service demanded by the use of high-speed tool steels and, as demonstrated at work, are good machines for modern manufacturing or general shop use. A planer and a shaper of good design and strongly built are also shown. The radial drilling machines shown by the same company are of good design and well built; they are also well balanced as shown by the absence of vibration when working at high speeds; the speed changes are readily made and the tapping attachment is very good.

54 Gould and Eberhart exhibit a shaper of excellent design and workmanship adapted for heavy work. The arrangement for changing the length and position of stroke is very good. The motor that drives it has two speeds brought about by sliding the armature through the field of the motor which reduces the number of change wheels required in the gear box. The same firm shows a special gear cutter which cuts two blanks at the same time; this a strong, well built machine with several features that should be of interest.

55 In the extensive exhibit of products made by the Crane Co., is a motor-driven pipe-threading machine having two unusual at-

tachments—a quick centering rear chuck and compressed air cutting-off tools. The whole machine is well designed and strongly constructed and on account of the two unusual devices referred to is of

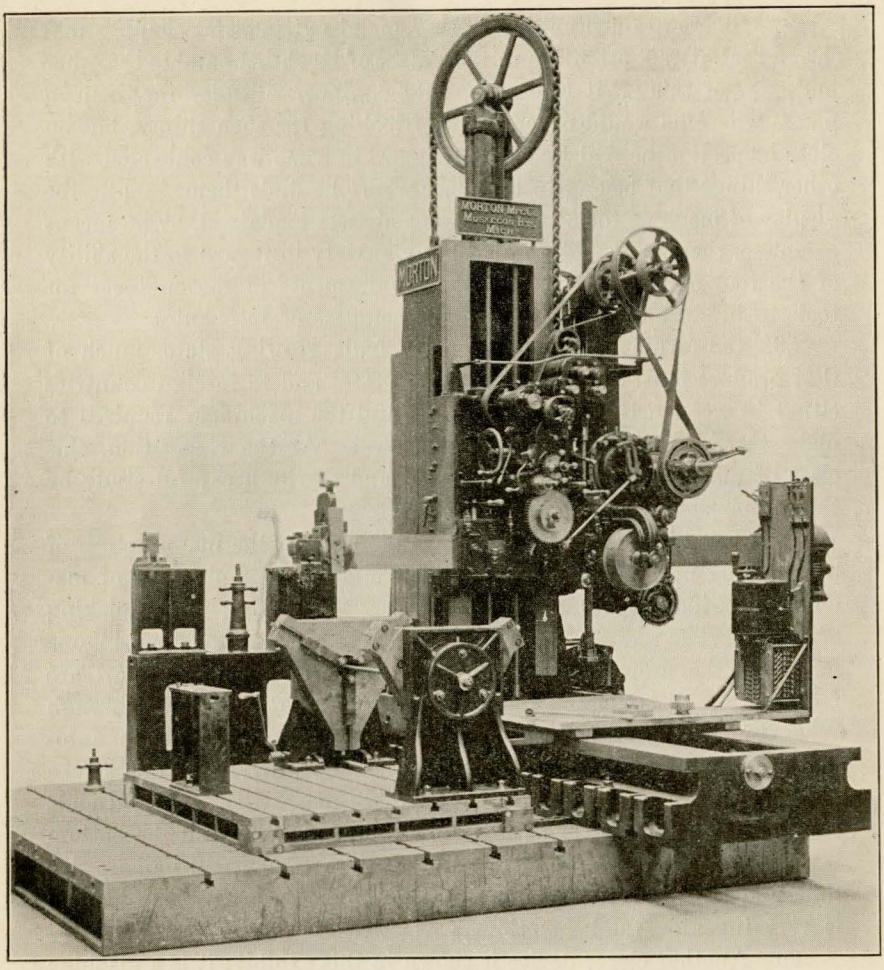

FIG. 12 CYLINDER PLANER EXHIBITED BY MORTON MANUFACTURING COMPANY

interest to those specializing in pipe work and fittings. This machine is made by the Crane Co. for its own establishments.

56 The Landis Tool Co. exhibits grinding machines of both universal and special application. The several machines are of high class design, massive in character and fitted to produce a wide range

of work. The excellent quality of their work shows the care displayed in the building of the machines and the arrangement of the exhibit shows the wide and varied application of these machines in the mechanic arts.

57 There are a number of other metal cutting and shaping machines that attract attention in the Palace of Machinery and in the other buildings of this great Exposition; the engineer will discover them in places where he would never think of looking for such things, but on close inspection he will find that they are in some way connected with other things that belong in the place where he finds them. While the display of machine tools is, for reasons already explained, by no means complete, there is enough to dispel any anxiety in regard to the ability of the tool makers to meet all the requirements of the engineer for tools to produce anything within the compass of mechanics.

58 California being an extensive fruit growing state, much of that product must be shipped to other states and to foreign countries either in wooden boxes or in tin cans and the machinery required to make these containers is of great interest. At the Exposition, this class of machinery is well represented and merits a careful study by those interested in automatic machinery.

59 The William S. Doig Co. are pioneers in the manufacture of box making machines. Their exhibit contains a complete set of machines of wide range and application for labor saving in the making of boxes. The sides and ends of a box are nailed together in one machine; the proper number of nails the correct distance apart are fed from a nail box above the machine; the nails come down through tubes to their proper position where they take their places automatically in the nail driving device and are all driven by one stroke of the machine. A matter of four strokes drives the sides and ends together. The box is then passed to another machine and the bottom is nailed on all four sides at one stroke. Three men will nail up five thousand fruit boxes in one day on these machines. The mechanism is very ingenious and functions perfectly.

60 Another clever device is shown in this exhibit; it is a machine for fastening two or more pieces of wood together edge to edge. On this machine a number of reels contain corrugated steel ribbons sharp on one edge; if the pieces to be fastened together are long enough to require say four fastenings then there are four reels. The strips to be fastened together are drawn in at one end and discharged at the other. The corrugated ribbons are drawn in at one side at right angles to the seam and are cut off in lengths of about 1½ in. and driven into

the wood across the seam making a solid joint. This machinery enables strips of any widths to be combined to make sides and ends, bottoms and tops of boxes, and saves much lumber that would otherwise be wasted. One machine with two boys will work up 4000 to 5000 feet of lumber in a day. The mechanical engineer will find much to interest him at this exhibit as the functions of the machine are readily followed.

61 At the George D. Parker exhibit two box making machines are shown, both new in design. One of these, the orange box machine, has now obtained a wide use in California. It is automatic and makes an orange box in four movements. First, the ends and middle blanks are pushed up into place; second, the slats forming the bottom are pushed forward from the back of the machine into place and nailed; third, the partly-formed box is turned on its side and the side slats pushed forward into place and nailed; fourth, the box is turned on the other side, the slats for that side pushed forward into place and nailed, and the finished box thrown out in front and the next movement brings up the ends and middle boards of the next box. Orange boxes come out of this machine at the rate of about 6 a minute, the whole process being automatic except the loading of the materials onto the tables. Another machine which has just been perfected after seven years' experimenting is shown. This completes a box at one stroke or revolution. The ends and sides are pushed up from below by a ram to the proper place while the bottom is pushed in from the back of the machine; the nailing mechanism acts simultaneously on the bottom and sides while a ram pushes the finished box out of the way of the material coming up for the next box. This universal machine is highly ingenious in design, entirely automatic in operation, of large capacity and has great economic value.

62 At the Max Ams Machine Co.'s exhibit is a complete set of can making machinery, arranged in the order usually occupied in a large can making establishment and being a complete outfit for making sanitary and open-top cans. Much ingenuity and good workmanship is displayed in this exhibit, but unfortunately the working out of the automatic operations has not been so coördinated in the display as to give great perfection of continuous operation. Still, these machines have a fine record on the Pacific Coast and a large proportion of the canning done here is in cans made by these machines.

63 In the E. W. Bliss Co.'s exhibit is a very complete operating exhibit of power metal working machinery illustrative of the high degree of perfection to which this class of machinery

has attained. The sanitary can making equipment is almost entirely automatic. The design of the different presses and carriers shows great mechanical ability; the automatic actions are perfect in operation displaying fine construction and accurate workmanship. To this equipment is attached an ingenious and effective can testing apparatus which charges each can with 40 lb. air pressure and passes it under water, immediately showing an air bubble if there is any leak; this testing is continuous and its speed equals that of the machine delivering the cans. The individual presses with semi-automatic attachments for the manufacture of various types of metal boxes and cans and the automatic threading machines show the same fine workmanship and precision of operation of the automatic working parts.

64 Also in the line of automatic machines, at the U. S. Army Ordnance Department exhibit is found a set of cartridge-making machinery in operation; this comprises a very interesting set of machines that show the result of the long process of perfecting required in machines for delicate operations. To such an extent has this perfecting been carried out that some of these machines are arranged to remind the operator of his omission should he neglect to do his part. This demonstration is very interesting and instructive.

65 As other instruments for cutting metals or other materials are coming into more extended use every day, the engineer will naturally look for some display of them and the work they do. He will find something worth while in this class at the exhibit of the Carborundum Co. in the Palace of Machinery. Here is shown an exceedingly high class exhibit of unusual educational value, extensive application of product, and instructive demonstration. The product of this company has revolutionized certain methods of manufacture, lowered costs and increased output. The application of the cutting wheels, cylinders, and discs extends from the cutting of the hardest crystals to the buffing of leather and cloth. This company has been the pioneer in this field, furnishing not only capital to establish a large business but also brains for original research. The engineer cannot fail to find this a most interesting exhibit.

66 Illustrative of cutting metals by a flame cutter, there are several exhibits of the oxy-acetylene cutting and welding equipments. The best exhibit is that of the Davis-Bournonville Co. in the Palace of Manufactures as it shows a complete oxy-acetylene equipment including the apparatus for producing oxygen. The generator for acetylene is of the latest design and the cutting torches are both hand and mechanically operated. The welding torches and gas regulators

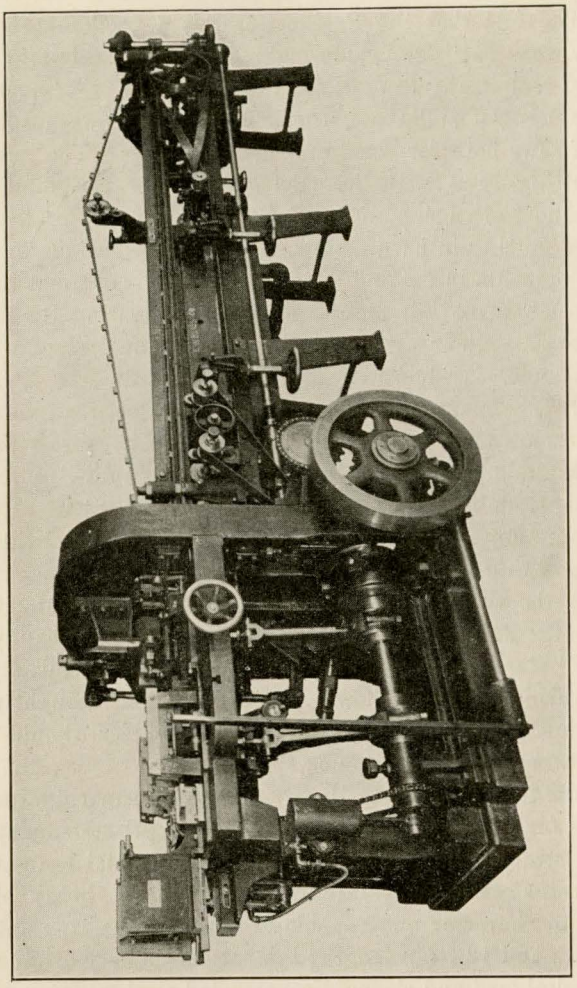

FIG. 13 E. W. BLISS CO.'S AUTOMATIC CAN BODY MAKER. CAPACITY 150 CANS PER MINUTE

are especially worthy of the closest study and show ingenuity and a high development in this new art. The radiographs and oxygraphs are unique. The exhibit in general shows the high development reached in the cutting and welding of metals by the oxy-acetylene flame.

67 The fact that the Pacific Coast is a good market for saws, especially wood cutting saws, brought some good exhibits of that class of cutting tool to the Exposition, the most notable being the exhibit of Henry Disston and Sons, Inc. This firm shows a splendid collection of saws both for wood and metal cutting. The new forms of metal cutting saws with inserted teeth show the most advanced practice, the teeth being made of the newest grade of tool steel for high speed cutting in hard metals. To a mechanical engineer seeking new developments in cutting tools this exhibit is of great interest. A very instructive moving picture exhibit, illustrating the methods of manufacture in their establishment and the quality and variety of their products, is shown by this company in the Pennsylvania Building. The many and varying grades of steel necessary for their productions are manufactured by the company itself and this specialization has undoubtedly been instrumental in building up an immense world-wide trade in Disston saws. It may be of interest to note that the Disston company has worked out and put in practical operation many interesting schemes for the welfare of its workmen.

68 As he works his way through the Palace of Machinery, the mechanical engineer, if he be at all interested in the shaping of sheet metal, will stand for a while at the exhibit of the Dreis and Krump Manufacturing Co., who show a line of very well thought out brakes for bending metal plates. Why these machines should be called "brakes" when their function is to bend not to break the materials they handle is a mystery to the writer. Three machines are shown, two being for light work, such as cornices or pilasters, adapted to all classes of straight line work, producing sheet metal boxes with right angle corners with great rapidity, and one for heavy steel plate, powerful in character and capable of bending to sharp angles plates $\frac{3}{8}$ in. thick and 12 ft. in length; this latter is a very original machine with well designed and strongly constructed steel working parts. This exhibit marks a decided advance in sheet metal working machines.

69 The Geometric Tool Co. in the Palace of Varied Industries exhibit tools for cutting external and internal threads, interesting on account of the fine and accurate workmanship and ingenious design displayed. The head for external threads opens automatically

as soon as the length of thread for which it is set has been cut. For internal threads, the taps automatically collapse at the points for which they have been set. In each case, when the thread is finished the chasers do not return over the threads on the reversing of the tool. These tools can be used in any screw machine or turret lathe and show a decided advance in tools of everyday use.

70 To the engineer interested in hydraulic press work, the exhibit of the Hydraulic Press Manufacturing Co. is especially interesting. This is an extensive display of presses including pumps, valves, etc., for the manufacture of cider, olive oil, etc., and for filtering the same. There are shown also presses for bending or straightening metal bars, pressing car wheels on to axles and other similar lines of work.

71 Among small tools are those shown by the Henry G. Thompson and Sons Co. in the Palace of Manufactures, whose exhibit consists of an interesting line of hack, power, and jig saws for cutting metals, and also some very clever tool holders. All the machines are shown in operation. The power hack saw is fitted with an ingenious pump for handling the lubricating compound and guide rollers for holding the saw blade in line. These improvements are a decided advance. The jig saw for cutting irregular contours in metal is an excellent machine. The saw blade at least 50 ft. in length is wound on a reel like a measuring tape; the free end does the cutting being operated from above; when the part cutting is used up, it is broken off and a new part brought up from the reel. The tool holders shown are novel, every variety of tool for one machine being carried by one holder.

72 The requirements of modern civilization have opened up many and varied fields for the engineer to cultivate for the good of humanity; this is very forcefully illustrated in the matter of food preservation and today there are large establishments devoted to the production of refrigerating machinery. There are four exhibits of refrigerating machinery at the Exposition that merit attention. Two of these are in the Palace of Food Products, one in the Horticultural Palace, and one in the Manufactures building.

73 The Larsen Ice Machine Co. have a very fine and interesting exhibit consisting of a complete plant for the freezing, storing, and hardening of ice cream, the daily capacity of the plant shown being 400 gal. This exhibit as a whole is of a very high character. The freezer cylinders and agitator are of German silver made without a seam, insuring perfect cleanliness; the arrangement and insulation

of the hardening chambers are also well worthy the attention of anyone interested in this class of machinery.

74 Near this exhibit is that of the York Manufacturing Co., which is an exhibit of a complete refrigerating plant in operation, keeping cold several chambers throughout the building. This company is one of the largest makers of this class of machinery in the United States and on that account the writer expected a finer display of their product. What is shown, however, is good.

75 The exhibit of a complete refrigerating plant by the Vulcan

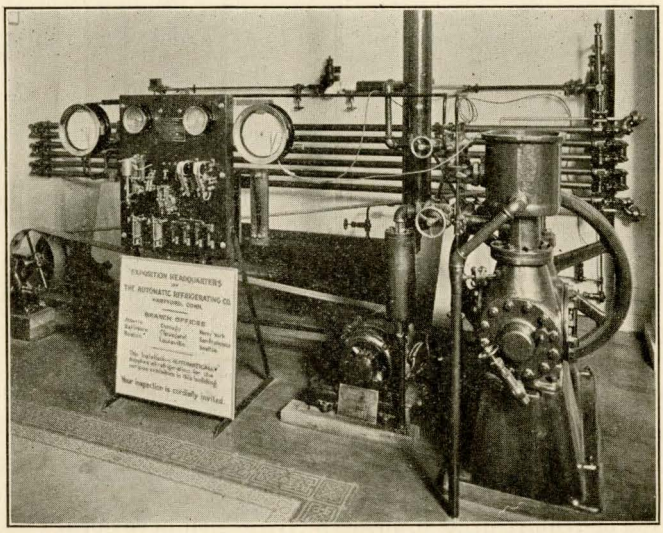

FIG. 14 REFRIGERATING PLANT EXHIBITED BY THE AUTOMATIC REFRIGERATING CO.

Iron Works will be found very interesting. The refrigerating chambers are a part of the exhibit and, being of glass, show the splendid condition of the foods inside, there being no sign of dampness either on the inside of the glass insulation or on the contained meats, butter, cheese, etc. This exhibit is a first-class illustration of the whole refrigeration process and affords valuable information on this subject.

76 The remaining exhibit of refrigerating machinery is by the Automatic Refrigerating Co. This is the only complete, automatically controlled refrigerating plant on exhibition. The automatic control is a decided step in advance on new ground; it automatically stops the machine when the temperature in the refrigerated chamber

reaches a point one degree below the temperature for which the machine is set and starts it again when the temperature is one degree above that point. This automatic regulation also applies to any number of chambers working at different temperatures. The chambers on which this machine is operating are used in connection with fruit exhibits, and during certain parts of the day they are opened very frequently. Cards taken from the pressure recorder on the ammonia pump show this very well and it can be noted that during the cooler part of the night and when the chambers are not opened the machinery runs about 4 min. and stands 15 min. very regularly.

77 There are many other engineering exhibits in the Palaces of Machinery, Transportation, and Manufactures. Among those worthy of mention are the Dodge Manufacturing Co.'s exhibit of general power transmission machinery and accessories, which includes a good example of the Dodge system of rope drives. There is also the Zimer vibrating screen, an ingenious combination of reciprocating and tossing action by which the material is screened and conveyed at the same time, designed especially for moving and segregating hot ores, bolts, rivets, ashes, slag, etc.

78 The mechanical engineer depends so much for the success of his machinery on the quality of the lubricant he uses that the oil question is always an interesting one. The exhibit of lubricating oils made by the Union Oil Co. of California shows real achievement in petroleum technology and the company deserves great credit for its scientific development of lubricants from California crude oils. As petroleum specialists, they have succeeded in developing oils suitable for all classes of lubrication. For many years the crude oils that do not contain asphaltum have been considered necessary to meet these conditions. The exhibit shows that through scientific development the Union Oil Co. has contributed much to the knowledge available on the production of lubricating oils from crude petroleum.

79 What has been stated in regard to the above-mentioned exhibit applies equally to that of the Standard Oil Co., which has shown great skill in the treatment of oils for the many and varied uses to which its product is applied. Beyond simply covering the field of lubrication, the California oils show certain superiority that merits special recognition. This refers largely to the low cold tests of heavy lubricating oils.

80 To the engineer interested in the distribution systems of water works, the exhibit of the A. P. Smith Manufacturing Co., is one of great interest; this is a collection of water gate valves, fire hydrants, water works machines and appliances. The most interesting feature is the exhibit of appliances used for placing a gate valve into a line of main pipe while the latter is under pressure. This company is one of the oldest and best known in the manufacture of these specialties and their display is both instructive and attractive. In particular the tapping and valve inserting machines show great ingenuity.

81 The economical handling of materials in the shop is illustrated in the working exhibit of the Shephard Electric Crane and Hoist Co. This consists of electric power cranes and hoists for use from one or two overhead supports; also an electric winch, monorail track, and electric controllers and switches especially adapted for hoisting apparatus. The cranes and hoists are adapted especially for safe, convenient and rapid operation about shops, foundries, mills and warehouses. The mechanism is well protected against dust and grit. The monorail consists of two hard steel T-rails bolted to the lower flange of a standard I-beam without mutilating it; the strength is thus increased and wear on the supporting beam avoided.

82 The General Electric Co. shows a complete self-propelled electric truck on which is mounted an electric crane; this is demonstrated in operation and is an attractive and instructive exhibit.

83 The correct measurement of the quantities of liquids during their transmission through pipes has always been an interesting problem, and at the Exposition are two exhibits, that of the Neptune Meter Co. and that of the National Meter Co., illustrating apparatus for this purpose.

84 The Neptune Meter Co. shows a very complete and well arranged collection of various types of meters designed to measure and record different liquids in various units and quantities. They all show good design and excellent workmanship. Of special interest are the various sizes and valuable modifications of the old and well known disc type of meter and a meter known as the "Victor," of the oscillating piston type. A meter of the turbine type known as the "Crest" should be noted; it has two turbine wheels on the same shaft with the helical blades inclined in opposite directions, and is designed to measure large flows with slight loss of head and range in size from 1½ in. to 20 in. diameter. There are also shown various forms of compound meters, in which a meter of the disc type is combined with

a meter of the turbine type. These are all arranged so that when either meter is in operation the other is shut off by a valve. They are designed to measure accurately flows where the variation of inflow is very great, the small flows being measured by the disc meter and the large by the turbine meter.

85 A special form of the compound meter known as the "Protectus" is shown; this is of new design and contains in combination a disc meter, a turbine meter, and a "Control Orifice Tube" with an automatic check valve at the delivery end of the tube. This valve is operated by excess of pressure in the tube when the flow from the discharge pipe of the compound meter exceeds 50 per cent of the capacity of the disc meter. The opening of the check valve acts to mechanically close the outlet valve of the disc meter and stop its action and open wide the passage through the orifice tube and the turbine meter. The turbine meter is proportioned to measure 25 per cent of the flow through the orifice tube and to register the combined flow of itself and the orifice tube. A special adaptation of the disc meter is shown in an apparatus for measuring and recording a predetermined quantity of liquid and automatically stopping the meter and the flow when that quantity has passed the meter.

86 The National Meter Co. shows a large variety of types and sizes of meters for measuring and recording the flow of liquids. One with the trade name of "Crown" has been in use since 1879 and is still largely used for muddy water. Another with the trade name "Nash" of the nutating disc type is the most extensively manufactured; the disc is conical and has an unconstrained rolling movement in its conical seat and this permits small, solid particles to pass through without damage to the meter. Type K is a very highly developed disc type, in which all working parts may be removed without removing the body from the pipe line and without removing bolts. Damage by freezing is prevented by simple cast-iron washers under the bolt nuts which break under undue strain. A meter of the turbine type named "Gem" is shown; this is adapted only to the measurement of large and rapid flows and is used either alone or in combination with one of the oscillating piston type called "Empire," to form the "Empire Compound." In this arrangement the passage through the "Empire" is always open while that through the "Gem" is controlled by an automatic differential check valve which opens under the difference of pressure produced by a large flow through the "Empire" meter. This combination is said to have the accuracy of the "Empire"

for small flows and the freedom and accuracy of the "Gem" for large flows. Of special interest is an apparatus having the name of "Premier" to be placed in 30-in. water mains. It consists of one large and one small venturi tube in parallel relation. These tubes are so proportioned that the combined flow is 105 times that through the small tube and the flow through the small tube is measured and recorded by an "Empire" meter.

87 Both these exhibits of meters are of great interest to the engineering profession, which is sufficient excuse for giving a somewhat lengthy description of them.

88 At the Exposition there is a large amount of pumping machinery for all the varied purposes for which pumps are used. While much of this is of the ordinary type which can hardly expect much attention, there are, however, several exhibits in this class that the engineer will find interesting and a short notice of some of them will not be out of place.

89 The Luitweiler Pumping Engine Co. has an exhibit consisting of Luitwieler pumps of two different types adapted to surface, deep well and hydraulic service. The special feature is the method of driving. In place of the usual crank shaft operating through connecting rods there are eccentric or heart-shaped cams with the face of the cam working on rollers to produce the motion for the pump ram or bracket. The motion transmitted to two or more pump rods may be so arranged as to give a non-pulsating constant discharge of water or other liquid. The surfaces of the cams are hardened as well as the rollers; they are both generous in size and little wear need take place.

90 The Layne and Bowler Corporation exhibits a turbine pump especially adapted to deep wells. Its special feature lies in the pump chamber being suspended from its upper end, as are the rotating parts. The shaft rotates inside a central pipe in which it has bearings at intervals, lubricated with oil or clear water injected at the top of the pipe; the shaft bearings are thus protected from contact with dirty water. The rotating parts are carried on roller bearings at the upper end of the shaft, and for heavy pressures these are supplemented by oil pressure applied between one or more pairs of discs. Each rotating disc fixed to the shaft is enclosed within a close fitting bronze ring which has free lateral movement. This is a well-designed pump marking progress in a class of machinery that has been in a stationary condition for some time past.

91 The Krogh Manufacturing Company exhibits a variety of centrifugal, turbine, and plunger pumps for various uses which are of good design. Among these are a vertical centrifugal mine sinking pump, cornish pumps, jack head pumps, multi-stage mine station pumps, single-stage motor driven horizontal centrifugal pumps, multi-stage high pressure turbine pumps, and a long double-suction centrifugal pump with a capacity of 30,000 gal. per minute. The engineer finds several items for his note book in this exhibit.

92 The American Well Works has an exhibit consisting of a large variety of centrifugal, turbine, and deep well plunger pumps, of good design and well worthy of attention.

93 Closely connected with pumps are pipes, valves, and fittings. These are found in great variety and of all dimensions in the Crane Co.'s exhibit which fills a prominent place in the Palace of Machinery. Some of the main features of this exhibit are: One 72-in. wedge water gate in operation worked by a hydraulic lift and weighing 56,000 lb.; one 36-in. wedge water gate in operation worked by a motor; a complete line of steel water gates from 2 in. to 18 in.; one 12-in. high pressure water gate for 800 lb. pressure; a complete line of high pressure check valves for 1000 lb. pressure; a large assortment of water gate valves with and without indicators. This exhibit contains many more of the company's products than can be mentioned here and is one of the most notable features of the mechanical department.

94 There are many other exhibits that should have been mentioned if space permitted. In the Palace of Mines there is much that is interesting and new. This branch of engineering coupled with the advance in chemistry and metallurgy has made great progress in recent years and much of that progress can be traced in the exhibits in this building.

95 In the Palace of Transportation, the progress in that field of engineering can be traced through all its stages. In one corner is found an interesting old pioneer with the wagon in which he crossed the continent 65 years ago and from that point of beginning can be followed the progress in transportation up to the present day, when 60 miles an hour can be made on our improved highways with almost the comfort of a railroad coach. From the great exhibit of the Westinghouse Co. in this palace as a center, wherever one turns new wonders of mechanical genius continually arrest attention, and the skill that has conquered the land, the sea, and the air, all help to raise the engineer's estimate of the worth and dignity of the profession to which he belongs.

Standing

B. C. Bryan J. Hunter F. J. Frank W. H. Crosby C. Hering T. Morrin J. M. Smith
F. R. Low C. A. McAllister D. S. Watkins C. P. Poole H. W. Bringhurst W. K. Kavanaugh N. A. Bowers

Sitting

H. W. Hibbard J. T. Faig G. W. Dickie W. H. Onken, Jr. G. M. Brill C. W. Rice
C. E. Lucke J. C. Mengel G. W. Danforth C. M. Jansky E. S. Fischer

Absent: A. Gianini, W. Meredith, C. F. Pemberton

FIG. 12 INTERNATIONAL JURY OF AWARDS FOR DEPARTMENT OF MACHINE EXHIBITS
Panama-Pacific International Exposition, 1915

APPENDIX

Panama-Pacific International Exposition, 1915
International Jury of Awards

Grand Jury

Lieut. G. W. Danforth, *Chief of Exhibits*
Fred. R. Low, Mem.Am.Soc.M.E.
George W. Dickie, Mem.Am.Soc.M.E.
William H. Onken, Jr.
George M. Brill, Mem. Am.Soc.M.E.

Steam, Gas, Hydraulic and Other Motors

F. R. Low, Mem.Am.Soc.M.E., *Chairman*
Andrea Gianini, *Vice-Chairman*
Prof. H. Wade Hibbard, Mem.Am.Soc. M.E., *Secretary*
Captain B. C. Bryan, U.S.N.
John Hunter, Mem.Am.Soc.M.E.
Prof. C. E. Lucke, Mem.Am.Soc.M.E.
Wynn Meredith, Mem.Am.Soc.M.E.
Capt. C. A. McAllister, U. S. Coast Guard

Electrical Machinery

Frank Wolfe, *Chairman (Dept. D)*
Vito Capastini, *Vice-Chairman*
A. J. Halloran, *Secretary*
Charles A. Rolfe

Prof. V. Karapetoff, *Chairman (Dept. E)*
Prof. H. J. Ryan, *Vice-Chairman*
Guy L. Bayley, *Secretary*

William H. Onken, Jr., *Chairman (Dept. F)*
C. F. Pemberton, *Vice-Chairman*
Prof. C. M. Jansky, *Secretary*
Dr. Carl Hering
Cecil P. Poole, Mem.Am.Soc.M.E.

A. H. Babcock, *Chairman (Dept. H)*
Dr. George A. Damon, *Vice-Chairman*

Manufactures and Varied Industries

E. E. Crandall
Taichi Takezawa
Walter B. Frost
J. Gordino
Mrs. Florence Porter Pfingst
Herman Rosse
T. M. Shearman
Fred Dohrmann
Milward Adams
Yugi Nagashima
Nobuichi Kasuga
William McCann
Thomas C. Kurtz
Prof. V. Karapetoff
Guy L. Bayley, Mem.Am.Soc.M.E.
L. P. Lowe
Frank A. Cressy, Jr.
Mrs. Jules Kraus
L. Y. Ho
Charles B. Newman
Guillermo Aguirre

General Machinery and Accessories

George M. Brill, Mem.Am.Soc.M.E., *Chairman*
Emil S. Fischer, *Vice-Chairman*
Calvin W. Rice, Mem.Am.Soc.M.E., *Secretary*
N. A. Bowers
Harry W. Bringhurst
Thomas Morrin, Mem.Am.Soc.M.E.
Jesse M. Smith, Mem.Am.Soc.M.E.
William H. Kavanaugh, Mem.Am.Soc.M.E.

Tools for Shaping Wood and Metals

George W. Dickie, Mem.Am.Soc.M.E., *Chairman*
J. C. Mengel, *Vice-Chairman*
Prof. John T. Faig, Mem.Am.Soc.M.E., *Secretary*
William H. Crosby
F. J. Frank
D. S. Watkins

Mines and Metallurgy

Thos. T. Read, *Chairman*
L. Abelli, *Vice-Chairman*
Prof. W. R. Appleby
Marshall Dill
Prof. A. C. Lawson
D. McClure

Agriculture

Jos. J. Hittinger, *Chairman*
A. Fauzon, *Vice-Chairman*
Prof. R. L. Adams
W. A. Mace
E. J. Baker
Donald J. Linde
Henry H. Wing
S. Kasuga
Prof. F. W. Well
Alexander MacPherson
J. A. LeClerc
K. Ushijima
Prof. E. C. Montgomery
T. Z. Chang
Charles Carpy
A. S. Gouvea
C. J. Wood
H. M. Curran

Horticulture

Dr. A. W. Bitting, *Chairman*
A. Van Vliet, *Vice-Chairman*
Geo. C. Roeding
Louis Getz

Gift of
the Friends of the
San Francisco Maritime
Museum Library

J. Porter Shaw Library
San Francisco Maritime
National Historical Park

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Dickie, G. W.
Mechanical engineering at
the Panama-Pacific